An Evaluation of Models-3 Determination of $PM_{2.5}$ During the 1999 SOS Nashville Study

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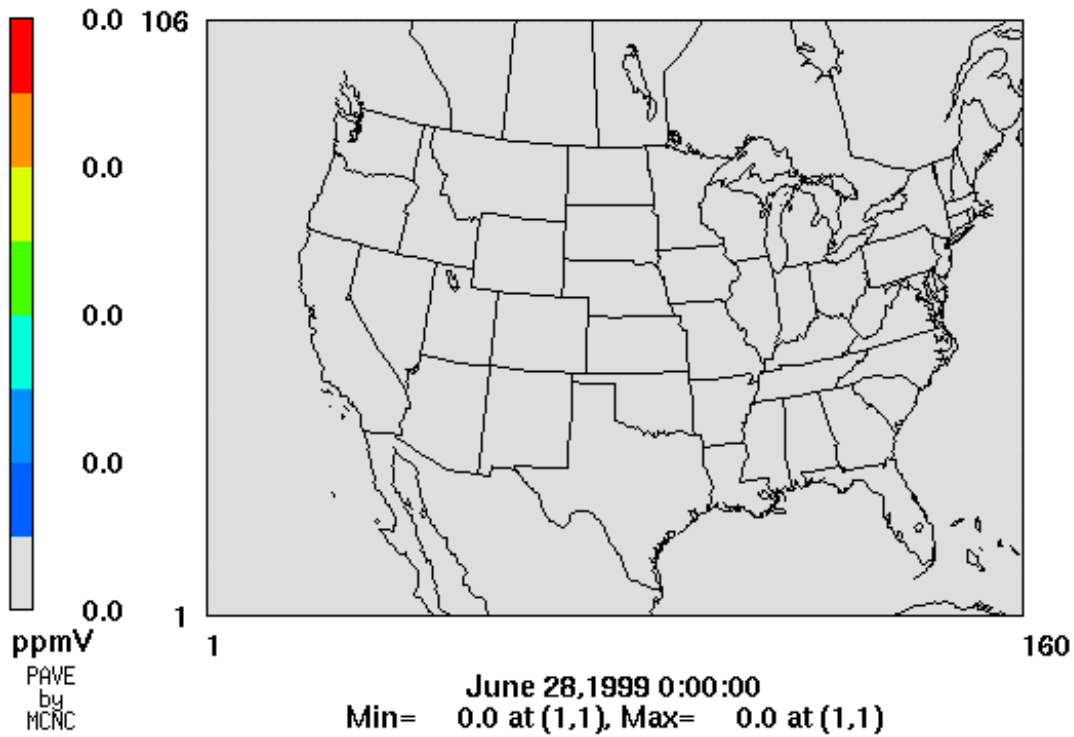
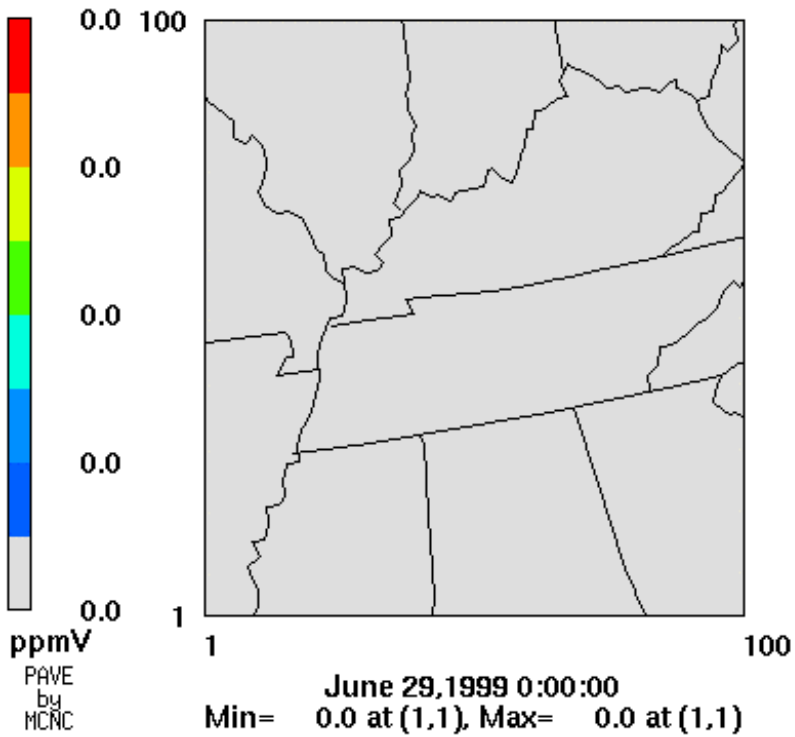
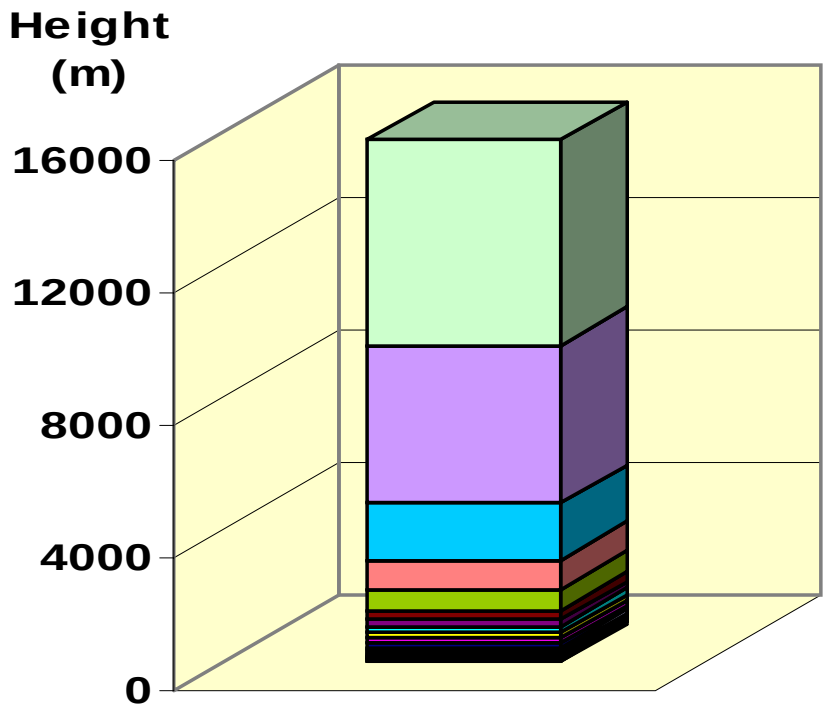
Domain of Coarse Grid



Domain of Fine Grid

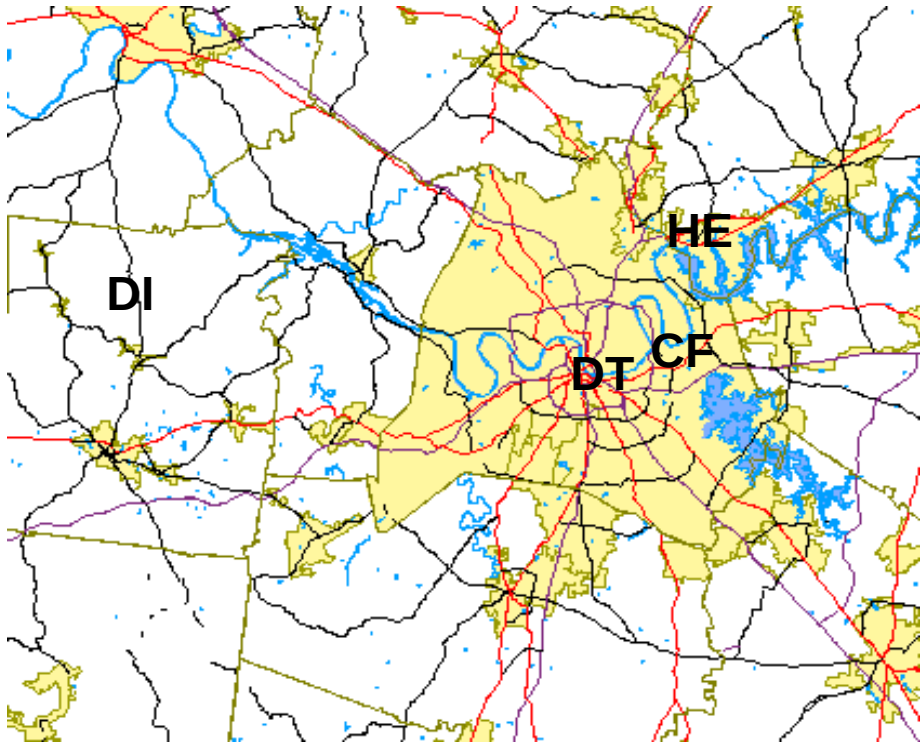


Vertical Layers Used in MM5 and CMAQ

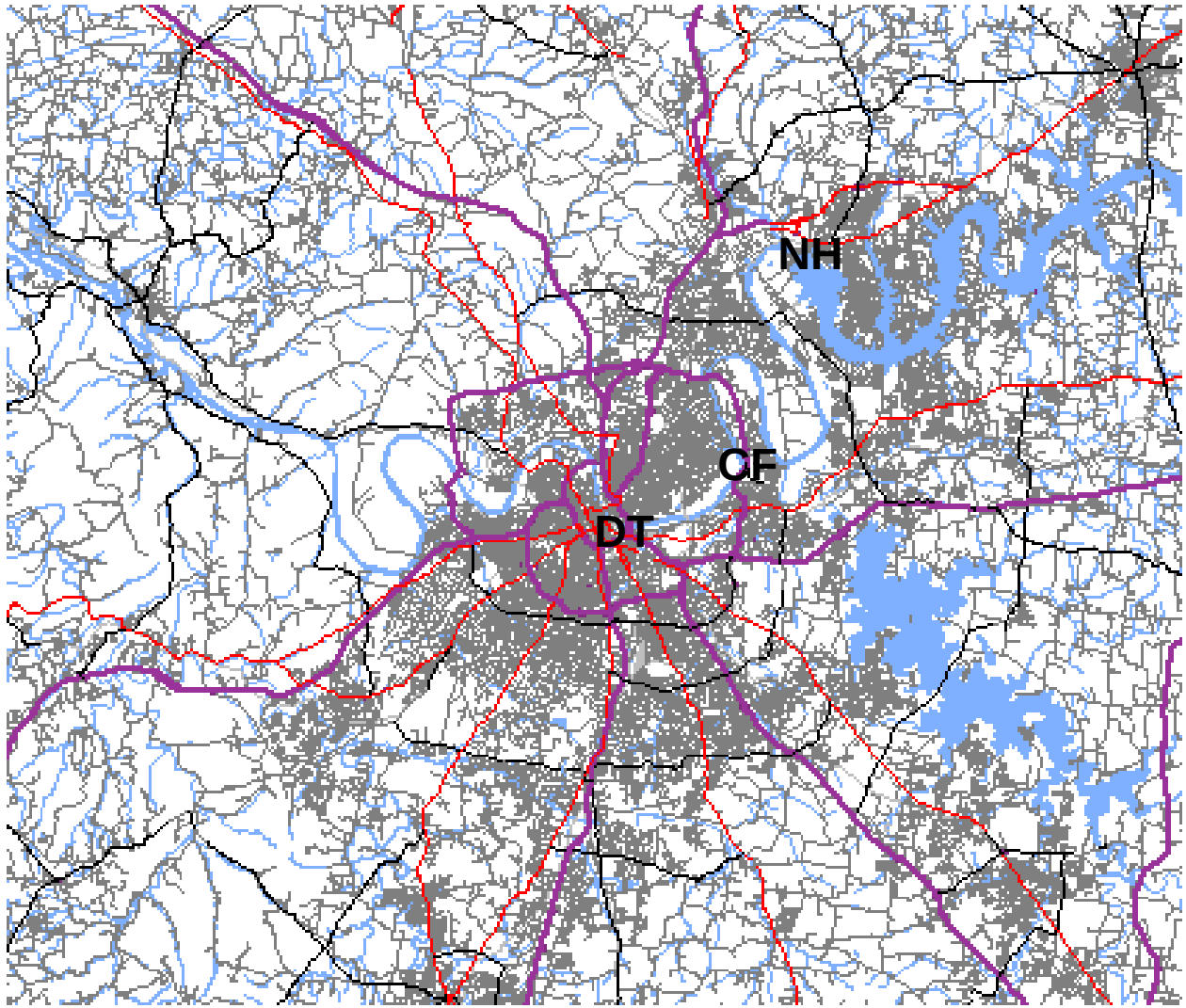


MM5: 31 vertical layers; CMAQ: 19 vertical layers

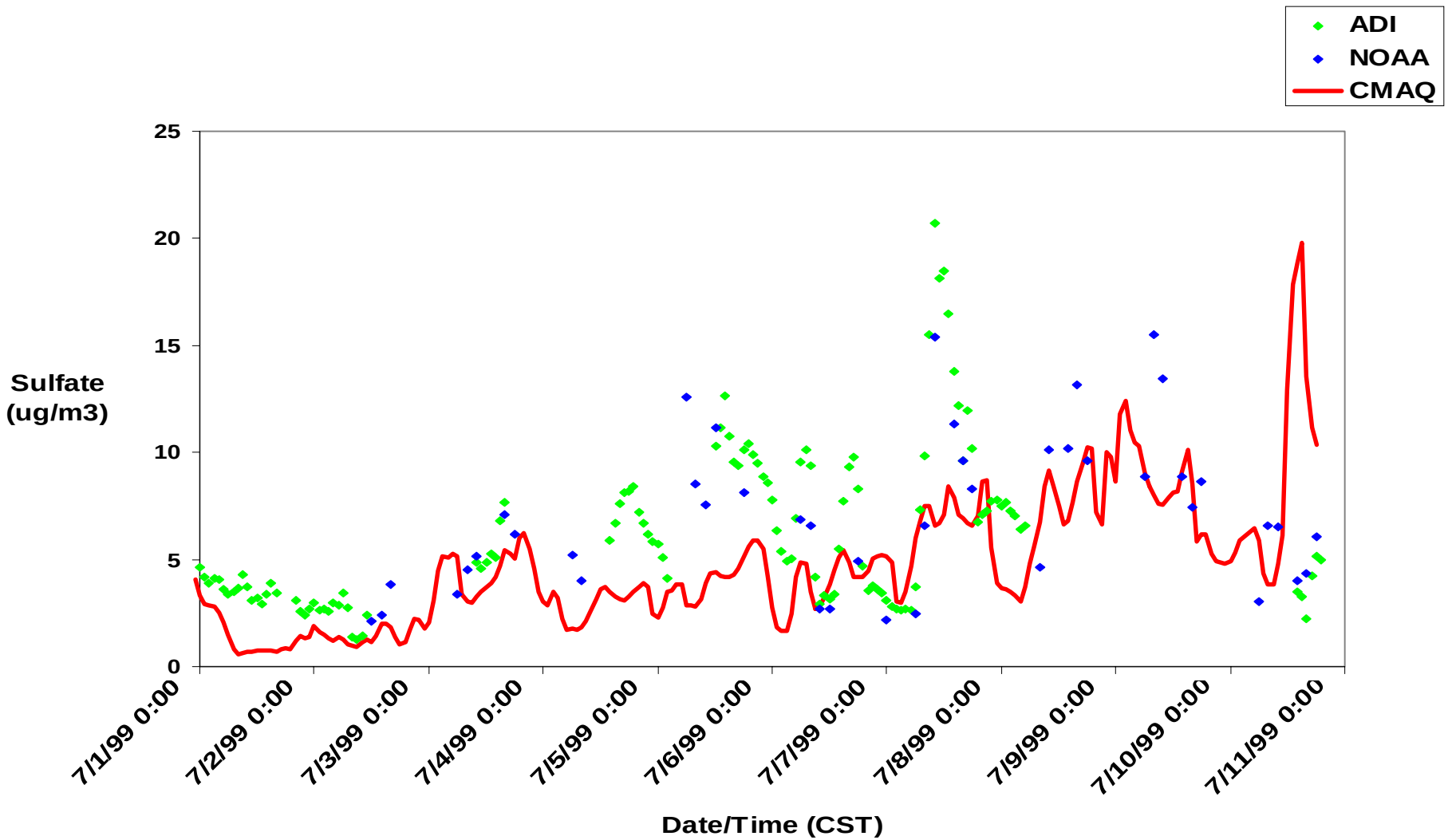
Ground-Level Sites – Nashville 1999



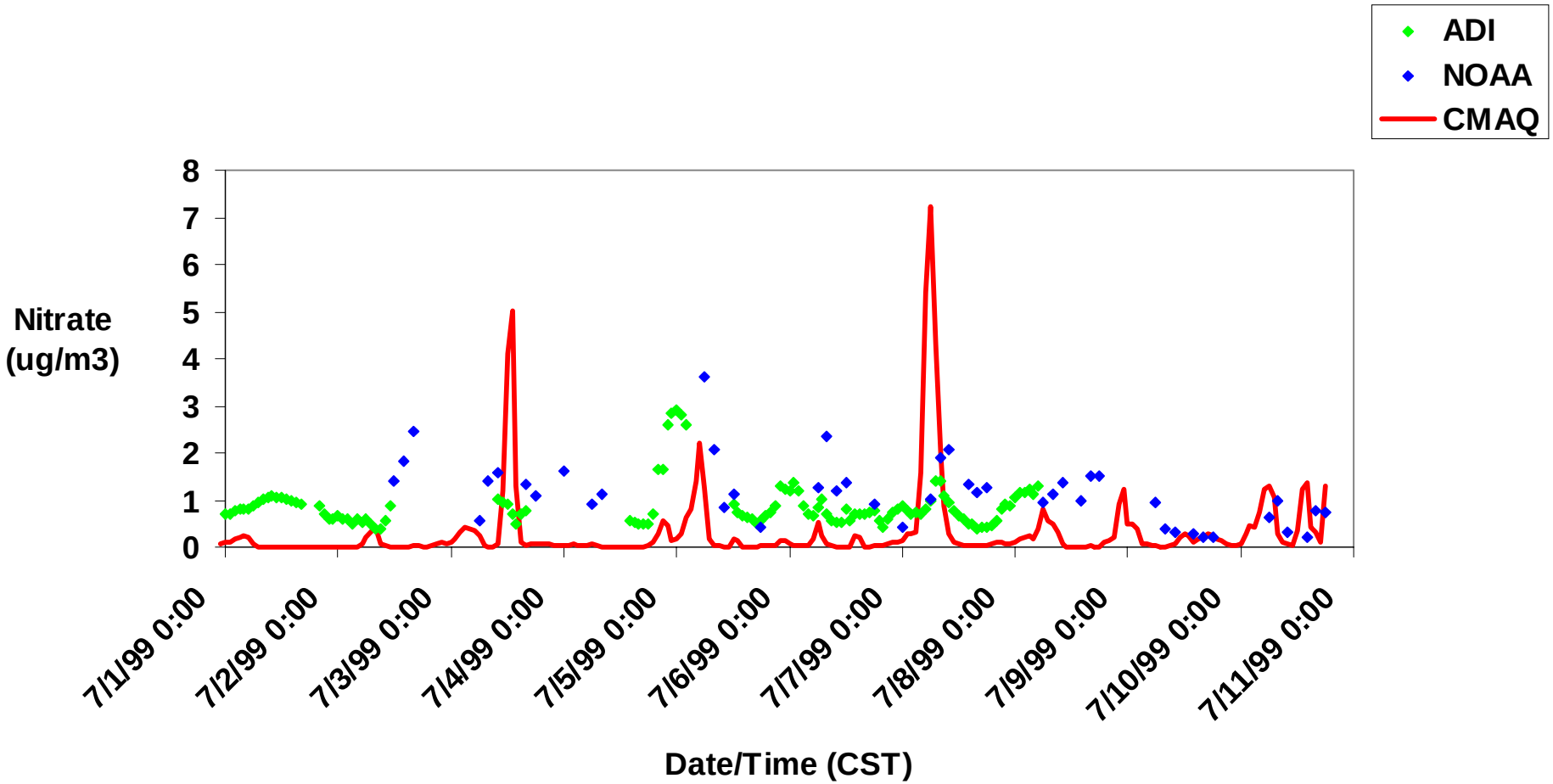
Ground-Level Sites - Nashville – 1999



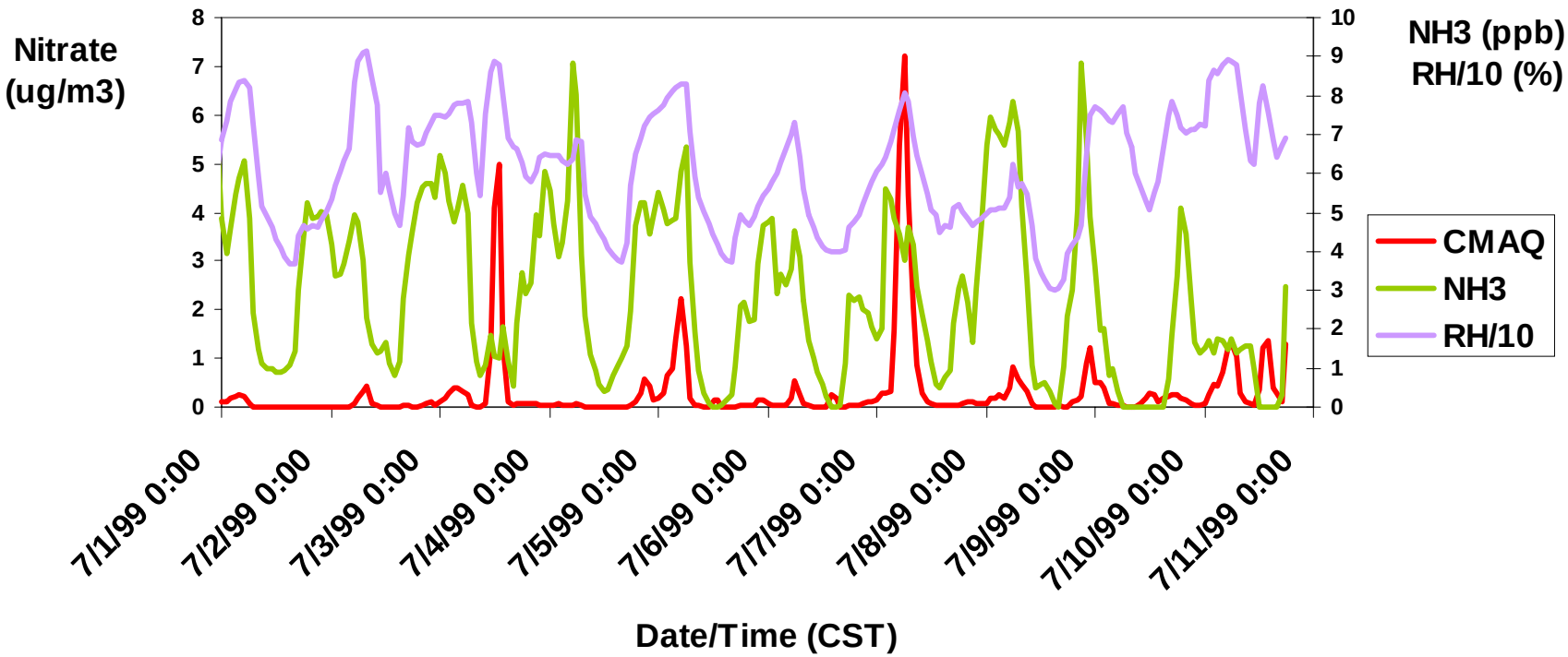
Hourly Averaged Particulate Sulfate Concentrations - SOS 1999 – Cornelia Fort



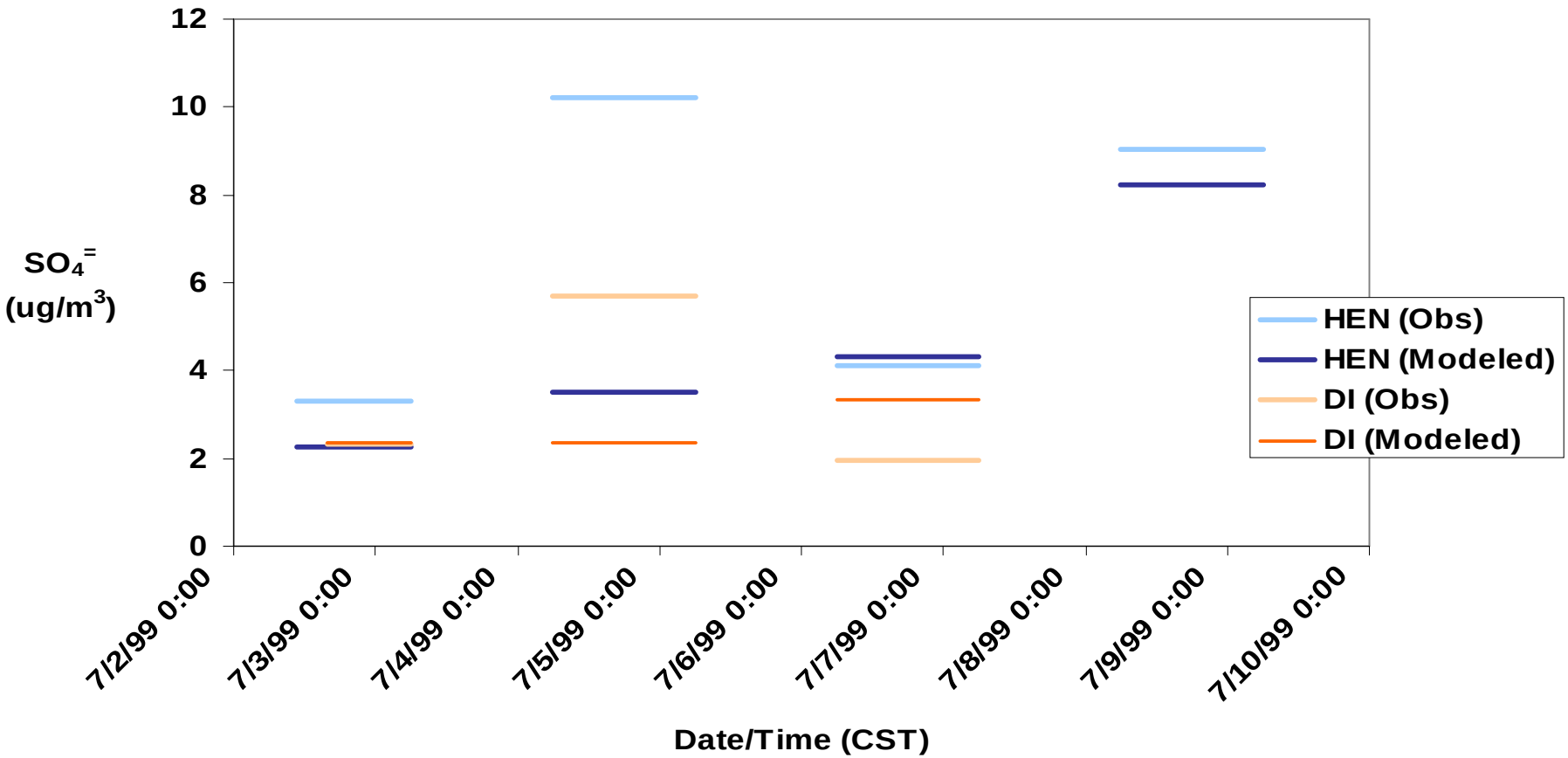
Hourly Averaged Particulate Nitrate Concentrations - SOS 1999 – Cornelia Fort



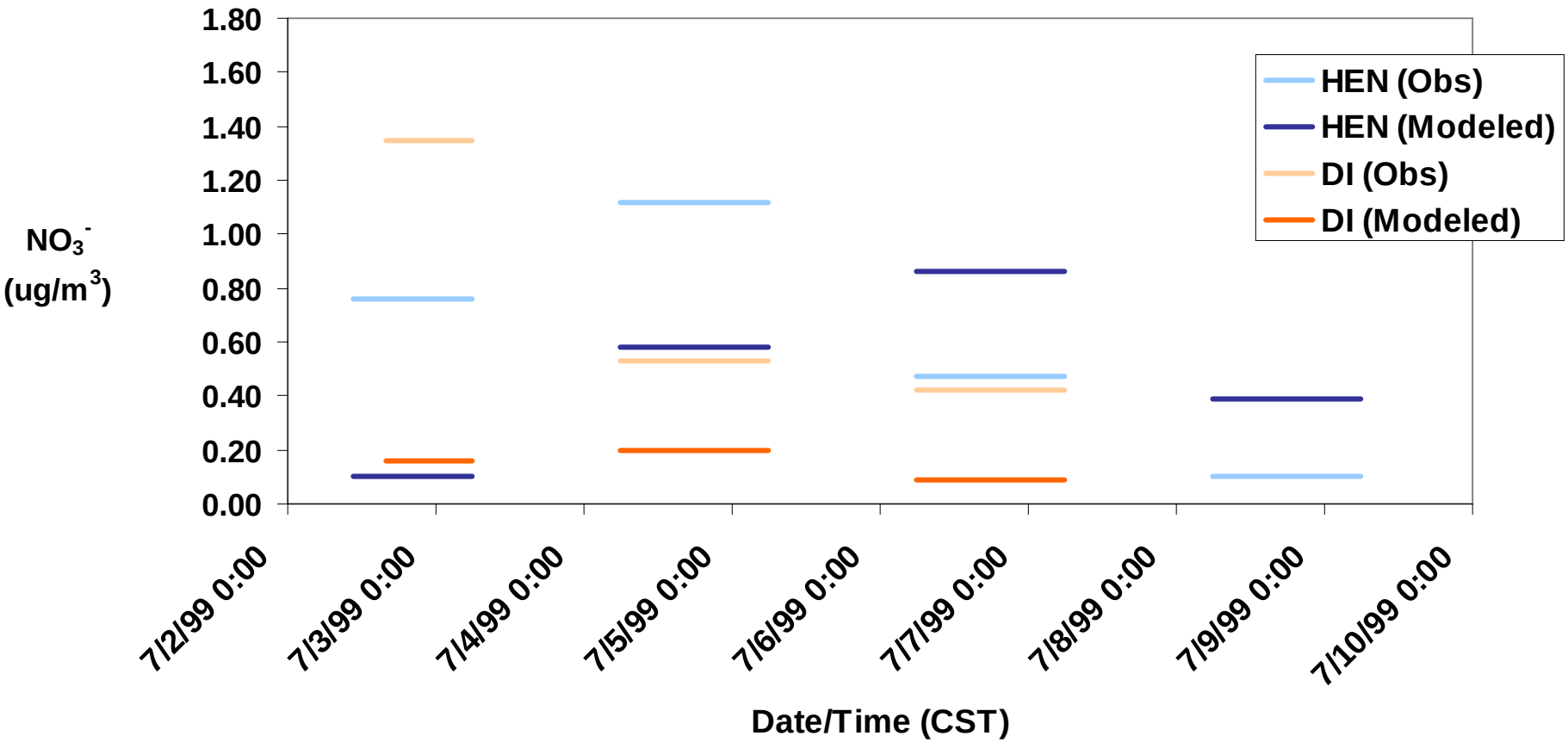
Timeseries of Nitrate
SOS 1999 – Cornelia Fort



PM2.5 Sulfate – Observed versus Modeled
SOS 1999 – Dickson and Hendersonville



$PM_{2.5}$ Nitrate – Observed versus Modeled
SOS 1999 – Dickson and Hendersonville



Model Performance for Sulfate and Nitrate at SOS 1999 Sites

Criterion: OBS/2 < MOD < OBS*2

Percent of Samples That Met Criterion

	Sample Duration	N	Sulfate	N	Nitrate
CF-ADI	(Hourly)	142	61.3%	138	9.4%
CF-NOAA	(Hourly)	45	75.6%	43	12.5%
DI/HEN	(Daily)	8	75.0%	8	25.0%

Speciation of $PM_{2.5}$ Data Sites Located on Fine Grid

SEARCH

Urban: N.Birmingham, AL

Jefferson St (Atlanta), GA

Rural: Yorkville, GA

IMPROVE

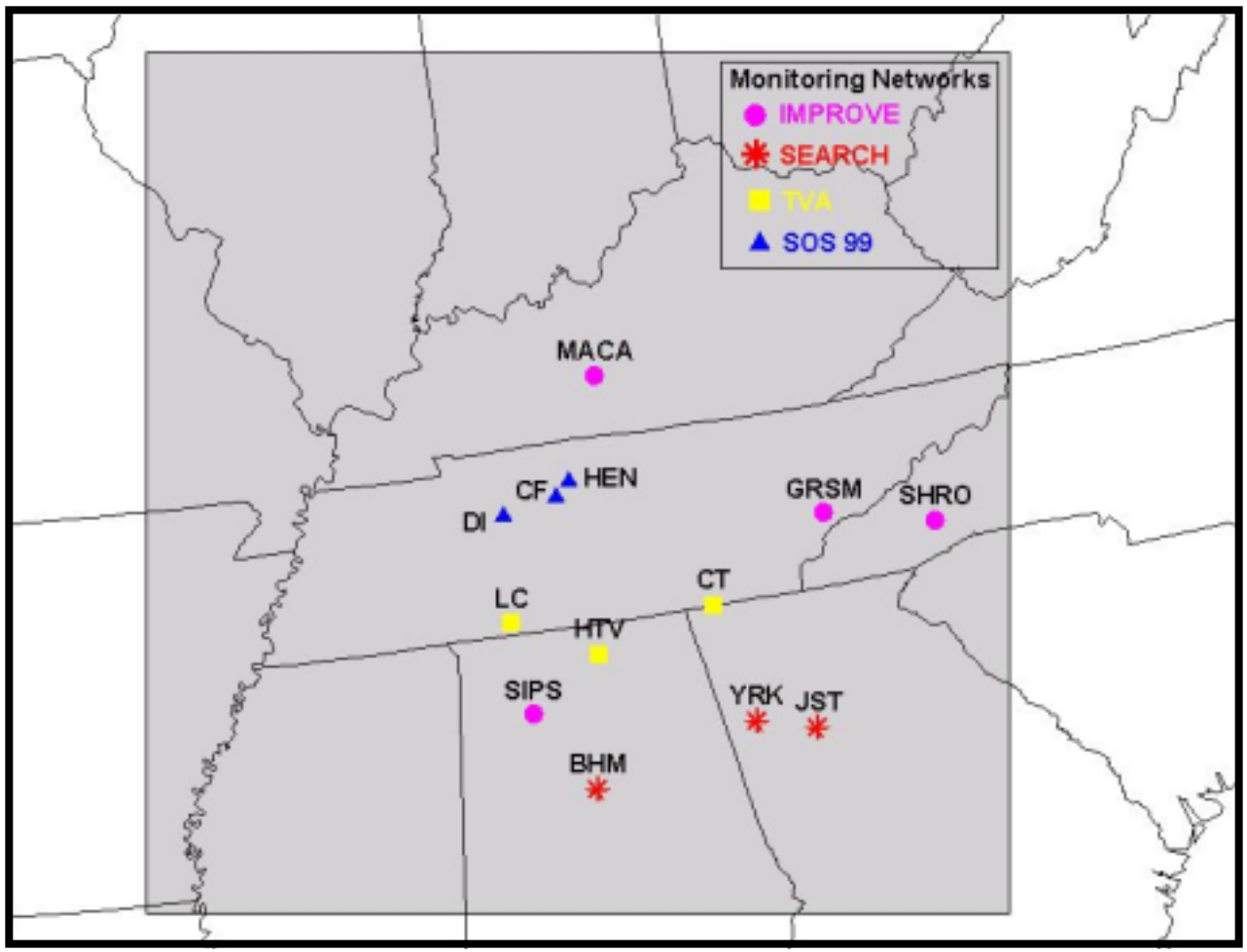
Rural: Sipsey, AL

Mammoth Cave, KY

GSMNP, TN

Shining Rock, NC

Monitoring Networks on Fine Grid



Model Performance – Sulfate SEARCH and Improve Networks

Sulfate					
Date	Mean Observed (ug/m3)	Mean Bias (ug/m3)	Normalized Bias (%)	Mean Error (ug/m3)	Normalized Error (%)
07/01/1999	5.64	-2.49	-44.14	2.49	44.14
07/02/1999	4.23	-0.81	-19.06	0.90	21.32
07/03/1999	4.49	-1.60	-35.65	1.84	41.12
07/04/1999	3.19	-1.74	-54.50	1.74	54.50
07/05/1999	11.11	-8.65	-77.90	8.65	77.90
07/06/1999	9.83	-5.64	-57.39	5.64	57.39
07/07/1999	8.67	-2.53	-29.15	2.77	31.94
07/08/1999	7.75	0.90	11.65	0.90	11.65
07/09/1999	2.10	0.97	46.21	0.97	46.21
Average	6.33	-2.40	-28.88	2.88	42.91

Model Performance – Nitrate SEARCH and Improve Networks

Nitrate					
Date	Mean Observed (ug/m3)	Mean Bias (ug/m3)	Normalized Bias (%)	Mean Error (ug/m3)	Normalized Error (%)
07/01/1999	0.60	-0.55	-91.90	0.55	91.90
07/02/1999	0.86	-0.83	-95.96	0.83	95.96
07/03/1999	0.54	-0.38	-70.05	0.44	82.52
07/04/1999	0.56	-0.55	-96.80	0.55	96.80
07/05/1999	0.69	-0.61	-89.33	0.61	89.33
07/06/1999	0.66	-0.61	-92.86	0.61	92.86
07/07/1999	0.57	0.08	14.56	0.27	46.69
07/08/1999	0.58	-0.52	-88.77	0.52	88.77
07/09/1999	0.59	-0.56	-96.06	0.56	96.06
Average	0.59	-0.50	-78.57	0.55	86.77

Model Performance – Ammonium SEARCH and Improve Networks

Ammonium					
Date	Mean Observed (ug/m3)	Mean Bias (ug/m3)	Normalized Bias (%)	Mean Error (ug/m3)	Normalized Error (%)
07/01/1999	2.54	-1.48	-58.06	1.48	58.06
07/02/1999	3.70	-2.80	-75.60	2.80	75.60
07/03/1999	2.14	-1.12	-52.47	1.15	53.82
07/04/1999	2.08	-1.60	-77.13	1.60	77.13
07/05/1999	3.31	-2.61	-79.07	2.61	79.07
07/06/1999	5.50	-4.35	-79.08	4.35	79.08
07/07/1999	3.88	-1.66	-42.70	1.86	47.90
07/08/1999	3.64	-1.75	-47.99	1.75	47.99
07/09/1999	1.20	-0.30	-24.60	0.30	24.60
Average	3.11	-1.96	-59.63	1.99	60.36

Model Performance -Total Organic Mass SEARCH and Improve Networks

Organics					
Date	Mean Observed (ug/m3)	Mean Bias (ug/m3)	Normalized Bias (%)	Mean Error (ug/m3)	Normalized Error (%)
07/01/1999	3.77	-1.06	-28.13	1.06	28.13
07/02/1999	4.16	-0.95	-22.79	0.95	22.79
07/03/1999	3.68	-1.34	-36.34	1.36	37.09
07/04/1999	4.97	-1.96	-39.39	2.17	43.62
07/05/1999	6.51	-3.24	-49.84	3.24	49.84
07/06/1999	6.62	-2.05	-30.99	2.05	30.99
07/07/1999	3.97	-0.49	-12.28	0.51	12.82
07/08/1999	4.25	-0.49	-11.46	0.49	11.46
07/09/1999	2.80	-0.39	-14.04	0.39	14.04
Average	4.53	-1.33	-27.25	1.36	27.86

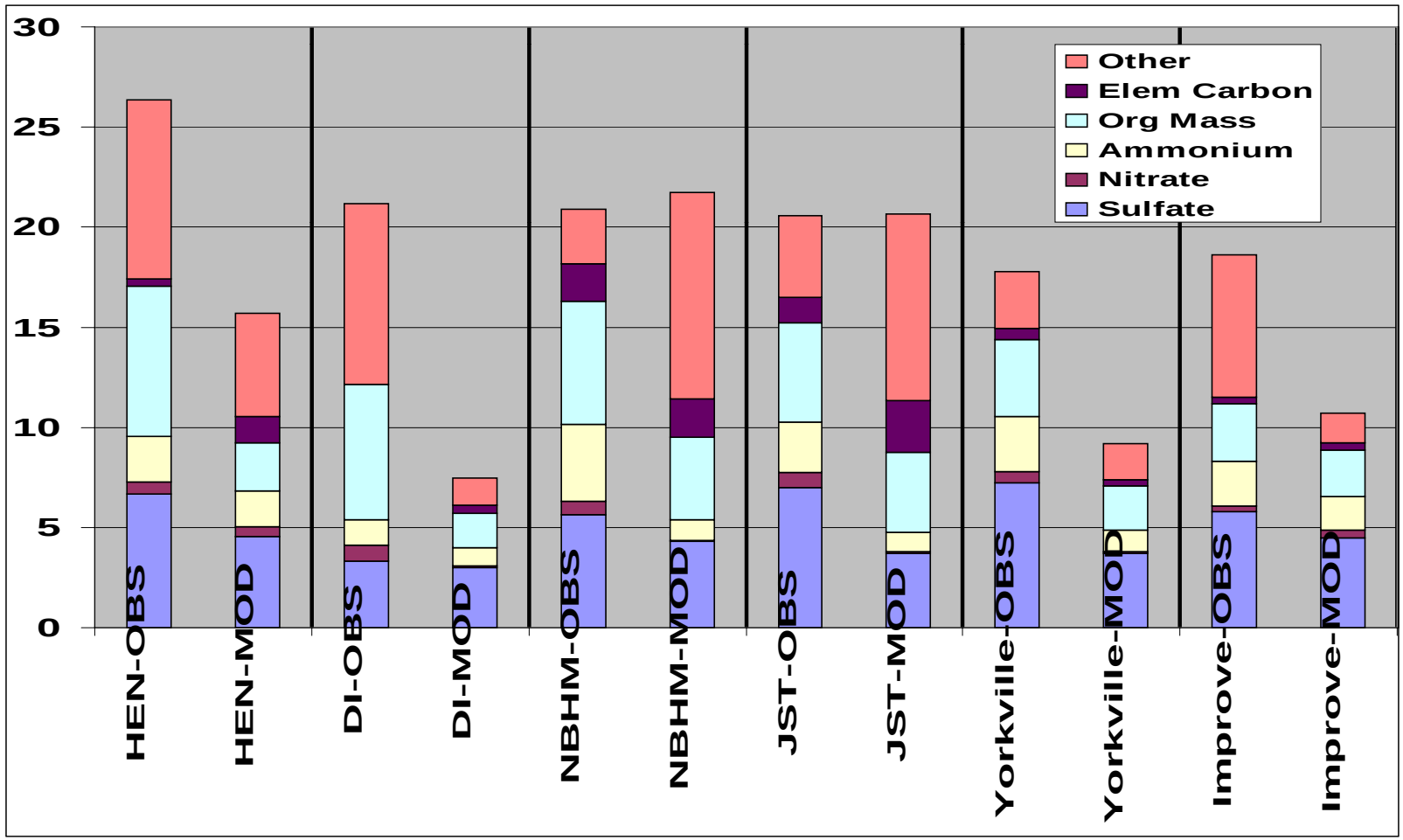
Model Performance - Elemental Carbon SEARCH and Improve Networks

Carbon					
Date	Mean Observed (ug/m3)	Mean Bias (ug/m3)	Normalized Bias (%)	Mean Error (ug/m3)	Normalized Error (%)
07/01/1999	1.08	0.43	39.83	0.84	78.07
07/02/1999	1.33	0.57	42.92	0.83	62.46
07/03/1999	0.56	0.39	68.49	0.55	97.90
07/04/1999	0.95	1.25	130.83	1.31	136.92
07/05/1999	1.45	0.94	64.92	1.02	70.53
07/06/1999	1.94	0.54	27.57	1.39	71.28
07/07/1999	0.82	0.01	0.81	0.09	10.56
07/08/1999	1.26	-0.06	-5.08	0.06	5.08
07/09/1999	0.80	0.13	16.63	0.13	16.63
Average	1.13	0.47	42.99	0.69	61.05

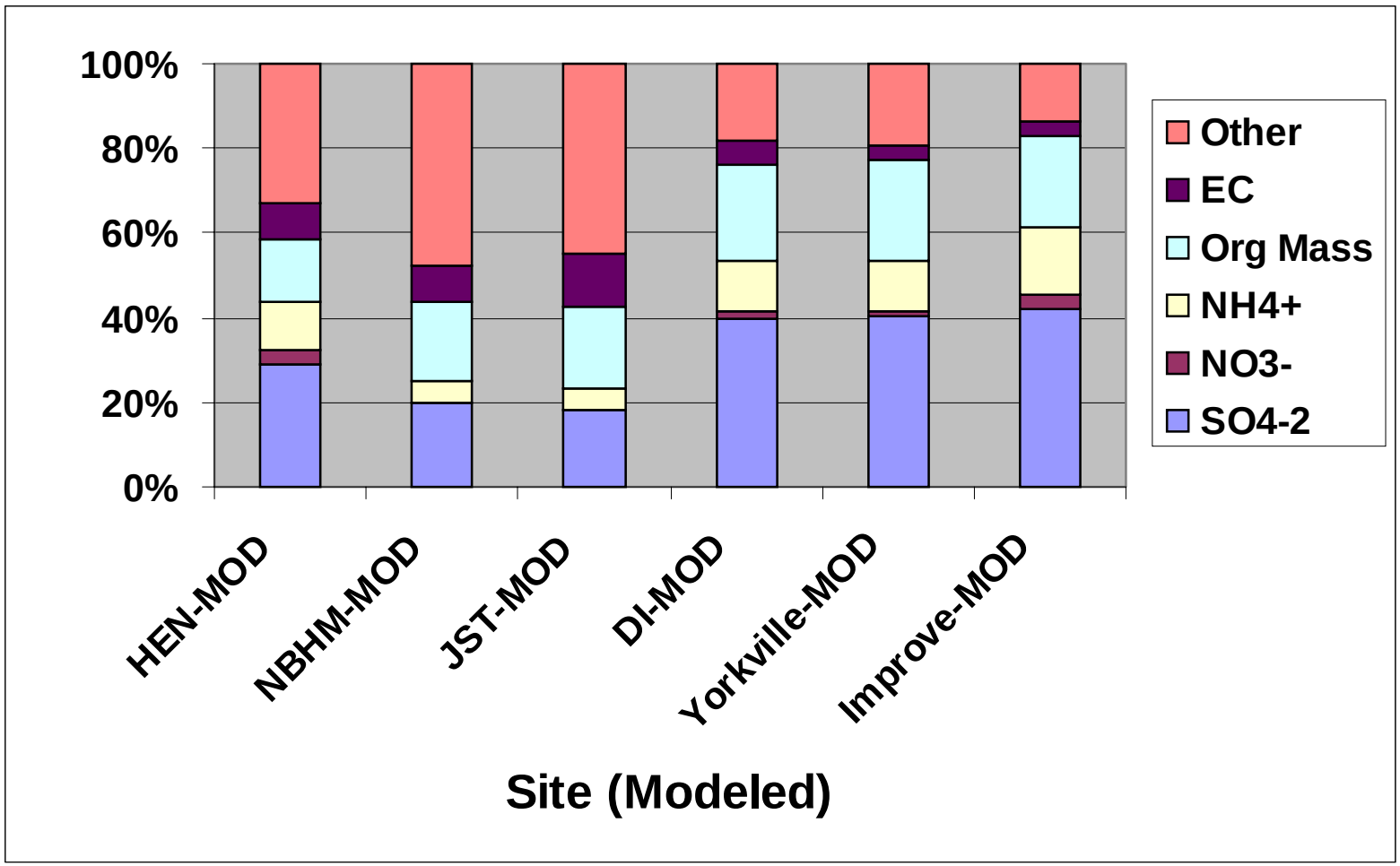
Model Performance – Total $PM_{2.5}$ SEARCH, Improve and TVA Networks

PM 2.5					
Date	Mean Observed (ug/m3)	Mean Bias (ug/m3)	Normalized Bias (%)	Mean Error (ug/m3)	Normalized Error (%)
07/01/1999	17.72	-2.81	-15.84	2.81	15.84
07/02/1999	15.79	-2.68	-16.95	3.97	25.15
07/03/1999	17.27	-6.90	-39.92	8.21	47.54
07/04/1999	17.56	-1.39	-7.94	1.39	7.94
07/05/1999	23.90	-12.55	-52.51	12.55	52.51
07/06/1999	26.85	4.16	15.48	4.16	15.48
07/07/1999	19.42	-2.61	-13.44	6.15	31.64
07/08/1999	18.54	3.32	17.88	5.92	31.95
07/09/1999	11.14	6.86	61.57	6.86	61.57
Average	18.69	-1.62	-5.74	5.78	32.18

$PM_{2.5}$ Speciation – Observed versus Modeled



Model Only
Rural vs Urban Sites



Acknowledgements

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SOS 99 – Cornelia Fort

Aerosol Dynamics, Inc (Susanne Hering)

NOAA Aeronomy Lab (Dick Norton)

SOS 99 – Dickson and Hendersonville

Georgia Institute of Technology (Karsten Baumann)

SEARCH Network

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Conclusions

- **Compared to observations from SOS99, and the SEARCH, Improve and TVA networks:**
- **Modeled sulfate, nitrate, total organic mass and $PM_{2.5}$ concentrations were usually lower.**
- **Modeled elemental carbon concentrations were usually higher.**
- **Agreement between observed and modeled total $PM_{2.5}$ does not indicate that observed and modeled speciation will be in agreement.**
- **At rural sites compared to urban sites, CMAQ results indicate lower concentrations of total $PM_{2.5}$, higher percents of sulfate and lower percents of elemental carbon and other.**